REMARKS

Reconsideration of the present application, as amended, is respectfully requested.

The December 18, 2002 Office Action and the Examiner's comments have been carefully considered. In response, claims 1-10 and 12-17 are amended, claims 18-21 are added, and remarks are set forth below in a sincere effort to place the present application in form for allowance. The amendments are supported by the application as originally filed. Therefore, no new matter is added.

Title and Specification

The title of the application has been changed to be more clear. Also, the specification has been amended to remove reference to the claims and to correct a minor typographical error.

Claim Objections

In the Office Action, claims 12 and 14 are objected to because of informalities.

In response, claims 12 and 14 are amended as suggested by the Examiner in a sincere effort to obviate the objection.

In view of the amendment of claims 12 and 14, reconsideration and withdrawal of the objection to claims 12 and 14 are respectfully requested.

Prior Art Rejections

In the Office Action, claims 1-5, 7 and 12-14 are rejected under 35 USC 103 as being unpatentable over USP 5,751,782 (Yoshitome) in view of USP 5,482,042 (Fujita) and USP 6,470,066 (Takagi et al). Claim 6, 8-10 and 15-17 are rejected under 35 USC 103 as being unpatentable over Yoshitome in view of Fujita and Takagi et al and further in view of USP 3,871,360 (Van Horn et al).

The prior art rejections are respectfully traversed for the following reasons, *inter alia*:

1. the cited prior art does not disclose, teach or suggest defining a plurality of different positions of an X-ray device including an X-ray source and an X-ray detector required to obtain the three-dimensional image data set with all of the X-ray positions being situated in a common plane; and/or

2. the cited prior art does not disclose, teach or suggest controlling the movement of an X-ray device and the acquisition of projection data sets by the X-ray device by means of a motion signal such that a projection data set during a low-motion phase

of the organ is acquired when the X-ray device is in each X-ray position required for the formation of a three-dimensional image data set.

Claim 1 has been amended to recite the steps of defining a plurality of different positions of an X-ray device including an X-ray source and an X-ray detector required to obtained the three-dimensional image data set with all of the X-ray positions being situated in a common plane and controlling the movement of an X-ray device and the acquisition of projection data sets by the X-ray device by means of a motion signal such that a projection data set during a low-motion phase of the organ required for the formation of a three-dimensional image data set is acquired when the X-ray device is in each X-ray position.

Claim 12 has been amended to recite a processing (arithmetic) and control unit for controlling movement of the X-ray device to the different X-ray positions and acquisition of projection data sets by the X-ray device by means of the measured motion signal and forming the three-dimensional image data set such that the projection data sets required for the formation of the three-dimensional image data set are acquired from the different X-ray positions with each projection data set being acquired when the X-ray device is in a respective X-ray position and during a low-motion phase of the organ.

As disclosed in the specification, the X-ray device is moved to the different X-ray positions P0-P12, all situated in a common plane, and while at each position, a projection data set D0-D12 is acquired. By controlling the movement of the X-ray device to the different positions and the on-off status of the X-ray device, it is possible to acquire projection data sets at each X-ray position when the motion signal is at a low-motion phase (see the paragraph bridging pages 6 and 7).

Yoshitome, Fujita and Takagi et al., taken individually or in combination, do not disclose defining X-ray positions and controlling an X-ray device in the manner now set forth in amended claims 1 and 12.

Yoshitome shows an apparatus wherein a signal representative of the organ phase is used to periodically trigger acquisition of projection data sets. As admitted by the Examiner, Yoshitome does not disclose controlling an X-ray device based on a motion signal to acquire projection data sets from selected X-ray positions to enable the formation of a three-dimensional image data set therefrom.

Takagi et al. shows an apparatus for performing CT scans in which each scan is started at the phase of an R wave determined from an electrocardiographic complex. In this manner, tomographic

images in slice faces are obtained at identical phases of cardiac motion.

In contrast to the present claimed invention, there is no definition of X-ray positions in a common plane from which projection data sets must be acquired in order to form a three-dimensional image data set. Rather, the X-ray positions are contained on a continuous path.

Fujita shows a medical imaging apparatus in which a three-dimensional image is formed from a plurality of two-dimensional scans. In contrast to the present claimed invention, there is no definition of X-ray positions in a common plane from which projection data sets must be acquired in order to form a three-dimensional image data set.

Furthermore, there is no explicit mention in Yoshitome, Takagi et al. or Fujita of controlling movement of the X-ray device to all of a plurality of different positions in a common plane to enable acquisition of projection data sets when an organ is in a low-motion phase.

Thus, Yoshitome, Fujita and Takagi et al. do not disclose all of the features of amended claims 1 and 12 and cannot be combined in any manner to render the claimed invention obvious.

Claims 2-10 and 13-17 are patentable over Yoshitome, Takagi et al. and Fujita in view of their dependence on claim 1 or claim

12 and because the prior art references do not disclose, teach or suggest all of the limitations recited in the dependent claims.

Claims 6, 8-10 and 15-17 are separately patentable over Yoshitome, Takagi et al., Fujita in combination with van Horn et al. because van Horn et al. does not disclose, teach or suggest having different X-ray positions in a common plane and controlling an X-ray device based on a motion signal to move the X-ray device through the different positions as set forth in claims 1 and 12.

Rather, van Horn et al. shows a system for timing imaging apparatus in which respiratory cycles of a patient are obtained and used to predict expected respiratory motion to thereby enable more accurate imaging.

In view of the foregoing, claims 1-10 and 12-17 are patentable over Yoshitome, Fujita, Takagi et al. and van Horn et al. under 35 USC 102 as well as 35 USC 103.

New claims

Claims 18-21 are added and are directed to the embodiment described in the specification at page 7, lines 14-24. In this embodiment, the X-ray device occupies each X-ray position and when in each position, waits until the motion signal is in the low-motion phase and then acquires a projection data set. The

cited prior art does not disclose, teach or suggest control of an X-ray device in this manner.

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If the Examiner disagrees with any of the foregoing, the Examiner is respectfully requested to point out where there is support for a contrary view.

Entry of the amendment, allowance of the claims, and the passing of the application to issue are respectfully solicited.

If the Examiner has any comments, questions, objections or recommendations, the Examiner is invited to telephone the undersigned at the telephone number given below for prompt action.

Respectfully submitted,

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Enc. - Copy of claim amendments showing changes made thereto
Copy of specification amendments showing changes made thereto

COPY OF CLAIM AMENDMENTS SHOWING CHANGES MADE THERETO

SERIAL NO. 09/668,938

1. (Thrice amended) A method [of] for acquiring a three-dimensional image data set of a [periodically] moving organ of [the] a body of a patient, comprising the steps of:

[irradiating the organ by means of]

defining a plurality of different positions of an X-ray device [which includes] including an X-ray source and an X-ray detector required to obtained the three-dimensional image data set, the X-ray positions being situated in a common plane,

detecting a motion signal [(H, B) which is] related to the periodic motion of the [body] organ and including a low-motion phase,

simultaneously with detection of the motion signal, [the acquisition of projection data sets (D_0, D_1, …, D_{16}), successively] moving the X-ray device to the X-ray positions and acquiring [the] a plurality of projection data sets [(D_0, D_1, …, D_{16})] required for the formation of [a] the three-dimensional image data set [from different] , each of the projection data sets being acquired when the X-ray device is in a respective one of the X-ray positions [(p_0, p_1, …, p_{16}) , which x-ray positions are situated in one plane],

controlling the movement of the X-ray device and the acquisition of the projection data sets by the X-ray device by means of the motion signal [(H, B) to acquire] such that a

projection data set [(D_0, D_1, …, D_{16})] during a low-motion phase of the [body] organ [in each X-ray position (p_0, p_1, …, p_{16})] required for the formation of the three-dimensional image data set is acquired when the X-ray device is in each X-ray position, [wherein the motion signal (H, B) is used to control the x-ray device in such a manner that projection data sets (D_0, D_1, …, D_{16}) are acquired from individual, selected x-ray positions (p_0, p_1, …, p_{16}),] and

using the projection data sets [(D_0, D_1, …, D_{16})] acquired during the low-motion phases for the formation of the three-dimensional image data set.

2. (Twice Amended) The method as claimed in claim 1, wherein only the projection data sets [(D_0, D_1, ..., D_{16}) that have been] acquired during the same motion phases [(H_1, B_1)] are selected and used.

3. (Twice Amended) The method as claimed in claim 1, [wherein] further comprising:

successively moving the X-ray device to all of the [various] X-ray positions [(p_0, p_1, ..., P_{16}) are successively occupied] in an X-ray cycle [(R_1)], [that]

successively completing a plurality of X-ray cycles [(R_1, R_2) are successively completed], and

controlling the X-ray device [is controlled] by means of the motion signal [(H, B) in] such [a manner] that each X-ray cycle [(R_1, R_2)] commences in a different phase of motion [(H_1, H_2; B_1, B_2, B_3)] of the [body] organ.

4. (Twice Amended) The method as claimed in claim 1, wherein the X-ray device is controlled by means of the motion signal [(H, B)] such that projection data sets [(D_0, D_1, ..., D_{16})] are acquired only during low-motion phases [(H_1; B_1, B_3)] of the [body] organ.

5. (Twice Amended) The method as claimed in claim 1, wherein the X-ray device is controlled by means of the motion signal [(H, B)] such that the X-ray source is switched on [so as] to acquire projection data sets [(D_0, D_1, ..., D_{16})] exclusively during low-motion phases [(H_1; B_1, B_3)] of the [body] organ.

6. (Twice Amended) The method as claimed in claim 1, wherein a respiratory motion signal [(B) which is] dependent on the patient's respiration is acquired as a motion signal.

7. (Twice Amended) The method as claimed in claim 1, wherein a cardiac motion signal [(H) which is] dependent on the motion of the heart is acquired as the motion signal.

8. (Twice Amended) The method as claimed in claim 7, wherein in addition to the cardiac motion signal [(H) there is acquired] , a respiratory motion signal [(B) which is] dependent on [the] respiratory motion is acquired, [and] further comprising using the respiratory motion signal [(B) is used] to ensure that only [the] projection data sets [(D_0, D_1, ..., D_{16}) that have been] acquired during the same respiratory motion phases [(B_1)] are used to form the three-dimensional image data set.

9. (Twice Amended) The method as claimed in claim 8, wherein the respiratory motion signal [(B)] is used to correct, during the formation of the three-dimensional image data set, the projection data sets [(D_0, D_1, ..., D_{16}) that have been] acquired in different respiratory motion phases [(B_1, B_2, B_3)] and the shifts in position of the [body] organ resulting therefrom.

10. (Twice Amended) The method as claimed in claim 6, [wherein the respiratory motion signal (B) is used to inform] further comprising informing the patient that a desired

respiratory motion phase [(B_1)] has been reached [during which the acquisition of the projection data sets (D_0, D_1, ..., D_{16}) takes place] based on the respiratory motion signal.

12. (Thrice Amended) An X-ray device [which includes] comprising:

an X-ray source and an X-ray detector for [the acquisition of] acquiring a plurality of projection data sets [(D_0, D_1, …, D_{16})] from different X-ray positions [(p_0, p_1, …, p_{16})] and [for] enabling the formation of a three-dimensional image data set of a [periodically] moving organ of the body of a patient [(5)] from the projection data sets [(D_0, D_1, …, D_{16})], the X-ray positions being situated in a common plane, [and wherein there is provided an arithmetic]

means for measuring a motion signal related to the periodic motion of the organ simultaneously with the acquisition of projection data sets, the motion signal including a low-motion phase,

a processing and control unit for controlling movement of the X-ray device to the different X-ray positions and acquisition of projection data sets by the X-ray device by means of the measured motion signal and [for] forming the three-dimensional image data set such that the projection data sets [(D_0, D_1, …,

D_{16})] required for the formation of the three-dimensional image data set are [successively] acquired from the different X-ray positions [(p_0, p_1, …, p_{16}) which are situated in one plane, wherein a projection data set (D_0, D_1, …, D_{16}) is acquired] , each of the projection data sets being acquired when the X-ray device is in a respective one of the X-ray positions and during a low-motion phase of the [body] organ [in each X-ray position (p_0, p_1, …, p_{16}) required for the formation of the three-dimensional image data set, wherein the motion signal (H, B) is used to control the x-ray device in such a manner that projection data sets (D_0, D_1, …, D_{16}) are acquired from individual, selected x-ray positions (p_0, p_1, …, p_{16})], and

[wherein] the projection data sets [(D_0, D_1, …, D_{16})] acquired during the low-motion phases [are] being used exclusively for the formation of the three-dimensional image data set.

13. (Twice Amended) The X-ray device as claimed in claim 12, wherein the means for measuring the motion signal are arranged to measure a cardiac motion signal [(H) which is] dependent on [the] cardiac motion.

14. (Twice Amended) The X-ray device as claimed in claim [12] 13, wherein the means for measuring the cardiac motion signal [(H)] include one of[:] an electrocardiography device and a pulse oxymetry device.

15. (Twice Amended) The X-ray device as claimed in claim 12, wherein the means for measuring the motion signal are arranged to measure a respiratory motion signal [(B) which is] dependent on [the] respiratory motion.

16. (Twice Amended) The X-ray device as claimed in claim 15, [wherein there is provided] further comprising a signaling device for informing the patient that a desired respiratory motion phase [(B_1)] has been reached.

17. (Twice Amended) The X-ray device as claimed in claim 15, wherein the means for measuring the respiratory motion signal [(B)] include one of [:] an ultrasound device, an abdominal belt for measuring [the] motion of the diaphragm, and a resistance measuring device for measuring [the] resistance of [the] an abdominal region of the patient.

COPY OF SPECIFICATION AMENDMENTS SHOWING CHANGES MADE THERETO

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The paragraph beginning at page 1, line 1, has been amended as follows:

The invention relates to a method of acquiring a three-dimensional image data set of a periodically moving organ of the body of a patient [as disclosed in the introductory part of claim 1, as well as to an] <u>by means of an X-ray device in which projection data sets are acquired by the X-ray device simultaneously with a motion signal related to the periodic motion of the organ. The present invention also relates to</u> an X-ray device [, notably for carrying out such a method, as disclosed in the introductory part of claim 12] <u>including an X-ray source and an X-ray detector for acquiring projection data sets from different X-ray positions and enabling the formation of a three-dimensional image data set of a moving organ of the body of a patient from the projection data sets, and a mechanism for measuring a motion signal related to the periodic motion of the organ which is acquired simultaneously with the acquisition of projection data sets</u>.

The paragraph beginning at page 2, line 5, has been amended as follows:

[US] U.S. Patent No. 5,383,231 discloses a computed tomography (CT) system in which the projection data sets are acquired during a helical scanning motion of the X-ray source and the X-ray detector about the patient. At the same time, and independently therefrom, an electrocardiogram of the patient is recorded, the data of said electrocardiogram being used during the formation of the CT images and a three-dimensional image data set from the projection data sets so as to take into account the displacement of the patient table during the acquisition of the projection data sets and to evaluate exclusively the projection data sets acquired during a given phase of the cardiac motion. In order to realize a three-dimensional image data set therein, however, it is first necessary to calculate CT image data sets from the projection data sets; a three-dimensional image data set can [the] then be formed [therefrom] from the three-dimensional image set by means of interpolation algorithms. Furthermore, no direct and immediate link is provided between the acquisition of the electrocardiogram and the acquisition of the projection data sets by means of the X-ray device, so that a series of projection data sets which have been acquired during the wrong cardiac motion phase are not evaluated.

The paragraph beginning at page 2, line 25, has been amended as follows:

This object is achieved by means of a method [as claimed in claim 1] and an X-ray device [as claimed in claim 12] <u>in which simultaneously with detection of the motion signal, the X-ray device is moved to different X-ray positions situated in a common plane and a projection data set is acquired when the X-ray device is in each X-ray position. The movement of the X-ray device and acquisition of the projection data sets by the X-ray device are controlled by means of the motion signal such that a projection data set during a low-motion phase of the organ is acquired when the X-ray device is in each X-ray position. The projection data sets acquired during the low-motion phases are used for the formation of the three-dimensional image data set.</u>

The paragraph beginning at page 3, line 13, has been amended as follows:

Various attractive versions of the method according to the invention and various attractive embodiments of the X-ray device according to the invention are disclosed [in the dependent claims] <u>below</u>.

The paragraph beginning at page 4, line 16, has been amended as follows:

Advantageous embodiments of the means for measuring the motion signal are disclosed [in the claims 13 to 17] <u>below</u>.